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Publication date:
2017

Document Version
Peer reviewed version

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Citation (APA):
Hasager, C. B., Nygaard, N. G., Volker, P., Karagali, I., Andersen, S. J., & Badger, J. (2017). *Horns Rev 2 offshore wind farm photo case with wakes observed in 2016*. Abstract from Wind Energy Science Conference 2017, Kgs. Lyngby, Denmark.

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Horns Rev 2 offshore wind farm photo case with wakes observed in 2016

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Offshore wind farm wakes were photographed in foggy conditions at Horns Rev 2 on 25 January 2016 at 12:45 UTC (See¹). The study examines the atmospheric conditions from satellite images, radiosonde, vertical profiling wind lidar located at the transformer platform and SCADA data. Furthermore results from atmospheric WRF meso-scale modelling, Park wake model and large eddy simulation wake model are prepared and analysed. At the time of the photos a humid and warm air mass was advected from the southwest over cold sea. The dew-point temperature was such that cold-water advection fog formed in a shallow layer. Most turbines produced at or near rated power. The wind speed was 13 m/s at hub height and wind direction was from the southwest. The flow was stably stratified. The photo shows long, narrow wakes that persisted several rotor diameters downwind of the wind turbines. The LES model included a temperature scheme, and the results indicate the pattern of fog in the wake. Due to stable stratification the wakes are long and narrow with a smooth appearance. The LES results are novel and for the first time ever compared to visually observed fog cones. In the far-field of the wind farm wake mixing of warm air from aloft dispersed the fog. This is noted in the photos and WRF model results. The physical processes are modelled from WRF without and with a parametrization for the wind farm included. The results indicate a difference in liquid water content showing that a drying effect appear downwind of the wind farms for more than 100 km. Thus the photos confirm this drying process. It is the first time this is visualized and modelled for an offshore wind farm. Interestingly, these new images show highly contrasting conditions regarding the wind speed, turbulence intensity, atmospheric stability, weather conditions and wind farm wake development as compared to the well-known Horns Rev 1 photographs from 12 February 2008.

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Figure 1: Photograph of the Horns Rev 2 offshore wind farm on 25 January 2016 at 12:45 UTC seen from SSW direction. Photo by Bel Air Aviation Denmark, Helicopter Services. Source: Hasager *et al.* 2017 *Energies* doi:10.3390/en10030317